CONNECTOR AND METHOD OF USE OF THE CONNECTOR

This invention relates to a connector for the connection of the outer end portion of a pipe, a pipe line, a pipe string or coiled tubing, the connector moreover being formed for the connection of at least one piece of downhole equipment, a downhole tool etc., e.g. a drill bit, a drive engine for same, a measuring instrument etc. to carry out drilling, downhole operations or measuring, which connector comprises connectable parts for the connecting and securing of the pipe end portion, including an inner adapter sleeve and an outer adapter and connector sleeve, which can be connected to the connecting element of an end piece/connecting piece.

Also, the invention relates to a method of establishing the connection and securing the pipe end portion to the connector.

For connecting pieces for coiled tubing it is important, for space reasons, to allow the external diameter to be kept as small as possible, and it is also important that the connecting piece can stand high tensile loads, high pressure loads and the effect of high torques.

Existing connectors of this kind normally comprise an adapter sleeve with an externally conical smooth surface. Such an adapter sleeve with a smooth non-threaded surface will cause a great expansive force on an external adapter and connector sleeve surrounding the adapter sleeve, when the connector is subjected to tensile load. This disadvantageous condition is normally compensated for by increasing the external diameter of the connector, which is also unfortunate and disadvantageous.

A smooth conical adapter sleeve bearing against the surrounding end portion of coiled tubing, can only absorb a highly limited torque.

Existing connectors are generally locked by set screws meant to have the task of absorbing torques. This is a particularly unfortunate construction as such screws are completely unsuitable for such a task, and may, at worst, come loose through vibrations, and may fall out, after which the loose set screws may cause damage to the well and downhole equipment.

Therefore, the objective of the present invention has been to remedy or reduce, to a substantial degree, by simple means the drawbacks, disadvantages and limitations of use of conventional connectors of this kind and of other known connectors of similar types, and thus provide a connector for the purposes in question, in which the external diameter is kept as small as possible, and which exhibits, with dimensions corresponding to those of known connectors, a higher tensile end compressive strength and greater resistance towards external torques applied thereto.

A connector of the kind indicated in the introductory part of claim 1, distinguishes itself from conventional and other

known couplings through the features comprised by the characterizing part of claim 1.

As opposed to the state of the art, the adapter sleeve of the connector according to the invention has an external conical shape and is provided with external threads (normally left-hand threads), and, on the internal cylindrical surface opposite the coiled tubing, with friction-creating ribs, preferably in the form of (right-hand)threads.

This adapter sleeve is split and can be shrunk around the coiled tubing by means of the outer adapter and connector sleeve formed with a conical threaded inner surface complementarily corresponding to the conicity of the adapter sleeve. The sleeve wall of this outer adapter and connector sleeve is tapering gradually in the direction of the end piece incorporated in the connector, and can be screwed to the socket-like connecting element of said end piece, said connecting element having an externally conical sleeve wall tapering towards its free end, complementarily corresponding to the conicity of the outer sleeve, with external threads.

The socket-like connecting element of the end piece normally has a smooth cylindrical bore of a diameter insignificantly exceeding the outer diameter of the coiled tubing.

The diameter of the internally threaded bore of the outer sleeve exceeds, over almost the entire length thereof, the diameter of the coiled tubing, i.e. apart from an end portion positioned at maximal distance from said end piece, wherein the external sleeve is formed with an annular inward flange of a comparatively large axial extent and of a diameter which only insignificantly exceeds the outer diameter of the coiled tubing.

In this annular flange end portion is formed a circumferential groove which is open in the radially inward direction, and which accommodates a seal in the form of an O-ring. Another annular seal in the form of an O-ring is inserted in an internal circumferential groove formed in the socket-like connecting element in a position closer to the end piece than the position of an annular shoulder portion forming a stop and abutment surface for the end surface of the outer sleeve in the screwed together condition.

Due to the mutually cooperating, complementarily conical surfaces and sleeve walls tapering in opposite directions, the screwed-together outer elements, an outer adapter and connector sleeve and the socket-like connecting piece of the end piece, will together exhibit a minimal external diameter.

At the internal "ribs" of the inner, externally conical adapter sleeve, preferably in the form of right-hand threads, said right-hand threads will resist displacement of the inner sleeve and "bite" into the surface of the coiled tubing.

The externally conical adapter sleeve with external left-hand treads, incorporated in the connector according to the invention, will be capable of adopting torques, and the torque applied will tighten the inner adapter sleeve even more firmly to the external wall surface of the coiled tubing.

By high tensile loads the expansive forces will not be correspondingly high as when the inner adapter sleeve from known technique is externally smooth. By compressive forces the inner shrinkable adapter sleeve will tighten on the surrounding portion of the coiled tubing.

In the connecting of the coiled tubing, including securing thereof, and in the joining/screwing together of the different parts of the connector in the establishing of the connection, the procedure is preferably as follows:

The outer adapter and connector sleeve is passed over the end portion of the coiled tubing, so that its inward annular flange with the O-ring is the farthest from the end of the coiled tubing, so that the tapering of the sleeve wall towards the free end thereof, is pointing in the same direction as the free end portion of the coiled tubing.

As to the positioning of the outer adapter and connector sleeve on the coiled tubing, it is ensured that its free end, where the wall thickness is at its smallest, will be located at a relatively large distance from the end of the coiled tubing. Then the inner split shrinkable externally conical adapter sleeve with external threads is passed over the coiled tubing. The internal right-hand threads of the inner adapter sleeve act as friction-creating "ribs", and resist gliding of the inner adapter sleeve through rotation/displacement externally on the coiled tubing (also in the condition of use, when exposed to external forces).

Then the outer adapter and connector sleeve is screwed, by its internally conical threaded portion, along the externally conical threaded surface of the internal adapter sleeve, complementarily corresponding the conicity of the outer sleeve, and - as the inner diameter of the threads of the outer sleeve decreases - the inner shrinkable sleeve is compressed transversally thereby transferring compressive forces from the outer sleeve to the coiled tubing, which is thereby secured. When an optimal degree of securing has been achieved, the outer sleeve has, from its free end, a free (not in threaded engagement with the inner adapter sleeve) internally conical threaded end portion, which - on

adjustment, according to experience, of the position of the inner adapter sleeve relative to the end of the coiled tubing in the position of use - shall have a larger axial longitudinal extent than the dept of entering (depth of screwing) of the socket-like connecting element of the end piece, extending over said depth of entering, conically narrowing towards its free end.

In this position the socket-like connecting element of the end piece is screwed into said free internally threaded connecting portion of the outer sleeve, up to an annular movement-limiting abutment shoulder defining the socket-like connecting element innermost by the end piece, and determining its depth of entering into the outer sleeve.

Thereby the connection is established, and the end piece may be connected to a piece of downhole equipment, for example a tool, a drill bit, an engine, an instrument, a measuring device etc. whose kind is not an object of the present invention.

A non-limiting example of a present preferred embodiment will be explained in the following with reference to the accompanying drawings, in which:

Fig. 1 shows an axial section through a connector according to the invention with the end portion of coiled tubing secured therein;

Fig. 2 shows a cross-section through an inner and an outer adapter sleeve in the screwed-together position, corresponding to the established connection according to the sectional plane II-II of Fig. 1; and

Fig. 3 shows a perspective view of said inner adapter sleeve which is split longitudinally and can be shrunk transversally.

A connector for the connection of the end portion of a pipe, a pipeline, a pipe string or coiled tubing 10 comprises (besides the seals 12 and 14 in the form of O-rings positioned in internal circumferential grooves in the connector parts 16 and 18, which can be screwed together) three parts 16, 18 and 20 that can be screwed together.

A first part included in the connector has the form of an end piece 16 with an internally threaded conical bore 22 for the connection of downhole equipment/tools and a connecting socket 24 for the coiled tubing. The connecting socket 24 is externally conical and provided with external threads. Internally the socket 24 is cylindrical, so that the pipe wall is narrowing towards its free end.

The end piece 16 has a first, internal annular shoulder surface 26, which forms an abutment surface for the end surface of the coiled tubing 10. In an axial distance from this internal, annular abutment surface 26 the externally conical threaded socket-like connecting element 24 is defined by an, axially seen, annular shoulder surface 28 determining the dept of entering/screwing of the connecting element 24 into an outer adapter and connector sleeve 18 forming the second part of the connector.

The second part of the connector, in the form of an outer adapter and connector sleeve 18, is formed by an adapter sleeve element of an internally conical shape with an externally straight cylindrical jacket surface, so that the sleeve wall decreases successively in thickness towards the end which is directed towards the end piece 16, whereby the threaded internal wall defining the bore through the outer

adapter and connector sleeve 18, decreases in diameter in the direction away from the end piece 16. At that end, which is positioned at the largest distance from the end piece 16, the outer adapter and connector sleeve 18 is formed with an inward annular flange 30, whose diameter mainly corresponds to the outer diameter of the coiled tubing 10.

Internally in this annular flange end portion is formed an annular circumferential groove which accommodates a first seal in the form of an O-ring 14. At a certain axial distance from the seal 14 and internally in the end piece 16 is formed a circumferential groove for a second seal in the form of an O-ring 12.

The third part of the connector is formed by an inner externally conical and threaded adapter sleeve 20, which is shown in perspective in Fig. 3, in cross-section in Fig. 2 and in longitudinal section in Fig. 1.

This internal externally conical adapter sleeve 20 (internally exhibiting a straight cylindrical inner wall surface defining a bore) has a sleeve wall narrowing in the direction away from the end piece 16.

The conicity and threading of the inner adapter sleeve 20 complementarily corresponds to the conicity and threading of the outer adapter and connector sleeve 18. The same applies to the conicity and threading of the socket-like connecting element 24.

The inner adapter sleeve 20 preferably has external left-hand threads and may internally be formed - as a kind of ribs or other friction-creating/displacement-resisting projections opposite the surface of the coiled tubing 10 - with (right-hand) threads 34 which will efficiently resist sliding of the

inner adapter sleeve 20 on the coiled tubing 10 on rotation/displacement (in Fig. 2 the coiled tubing 10 has been left out for clarity). Here, cooperating threads on the outer and inner sleeves 18, 20 are identified by the common reference number 36.

The inner adapter sleeve 20 has a through slot 38, which will, together with specially selected spring steel or similar, make the adapter sleeve 20 shrinkable in the transversal direction when radial/transversal compressive forces are applied thereto by the outer sleeve 18 as a consequence of relative displacing movement of conical surfaces bearing on one another.

By the connection of the end portion of the coiled tubing 10, i.e. the outer portion which can be accommodated in the axial direction in the connector, the end surface of the coiled tubing 10 is abutting the axially innermost annular abutment surface 26.

The outer adapter and connector sleeve 18 is first passed over the coiled tubing 10 from the free end thereof, until this outer sleeve 18 adopts a position along the coiled tubing 10, in which its left-hand end of a minimal sleeve wall thickness is positioned at an axial distance from the outer free end of the connecting socket 24, said distance exceeding the axial length of the inner adapter sleeve 20.

Then the inner split, radially shrinkable adapter sleeve 20 is pushed and is brought to an initial position with its left-hand end at a suitable (experience will reveal how much this inner adapter sleeve can be expected to be moved axially by the displacing movement of the outer adapter sleeve towards the left during the engagement and displacement of its conical internal threads with/along the cooperating conical external threads of the inner adapter sleeve 20),

whereas the constantly decreasing diameter of the bore of the outer sleeve effects a radial compression, transversal "shrinkage", of the inner adapter sleeve, whose compressive forces ensure the securing of the surrounding annular portion of coiled tubing.

It is assumed that the inner adapter sleeve 20 is firmly connected and secured in a position, in which its left-hand end, according to Fig. 1, is positioned at an axial distance from the left-hand end of the outer adapter and connector sleeve 18, said distance exceeding the effective axial length of the connecting socket 24, so that said connecting socket 24 may now be screwed into the free (without the inner adapter sleeve 20 positioned radially within) end portion, until the free end surface of the connecting socket 24 abuts, in a movement-stopping manner, the, axially seen, outer annular abutment surface 28 of the end piece 16 limiting the depth of entering/screwing of the externally conical threaded connecting socket 24. Thereby the connection is established.